"Cities can achieve more sustainable land use if municipalities combine urban planning and development with environmental management"

-Ann Tibaijuki

Executive Director UN-HABITAT
Director General UNON 2007
(Tibaijuki 2007)

Chapter 5: Nairobi and its Environment

Nairobi's name comes from the Maasai phrase "enkare nairobi" which means "a place of cool waters". It originated as the headquarters of the Kenya Uganda Railway, established when the railhead reached Nairobi in June 1899. The city grew into British East Africa's commercial and business hub and by 1907 became the capital of Kenya (Mitullah 2003, Rakodi 1997).

Nairobi, A Burgeoning City

Nairobi occupies an area of about 700 km^2 at the south-eastern end of Kenya's agricultural heartland. At 1 600 to 1 850 m above sea level, it enjoys tolerable temperatures year round (CBS 2001, Mitullah 2003). The western part of the city is the highest, with a rugged topography, while the eastern side is lower and generally flat. The Nairobi, Ngong, and Mathare rivers traverse numerous neighbourhoods and the indigenous Karura forest still spreads over parts of northern Nairobi. The Ngong hills are close by in the west, Mount Kenya rises further away in the north, and Mount Kilimanjaro emerges from the plains in Tanzania to the south-east. Minor earthquakes and tremors occasionally shake the city since Nairobi sits next to the Rift Valley, which is still being created as tectonic plates move apart.

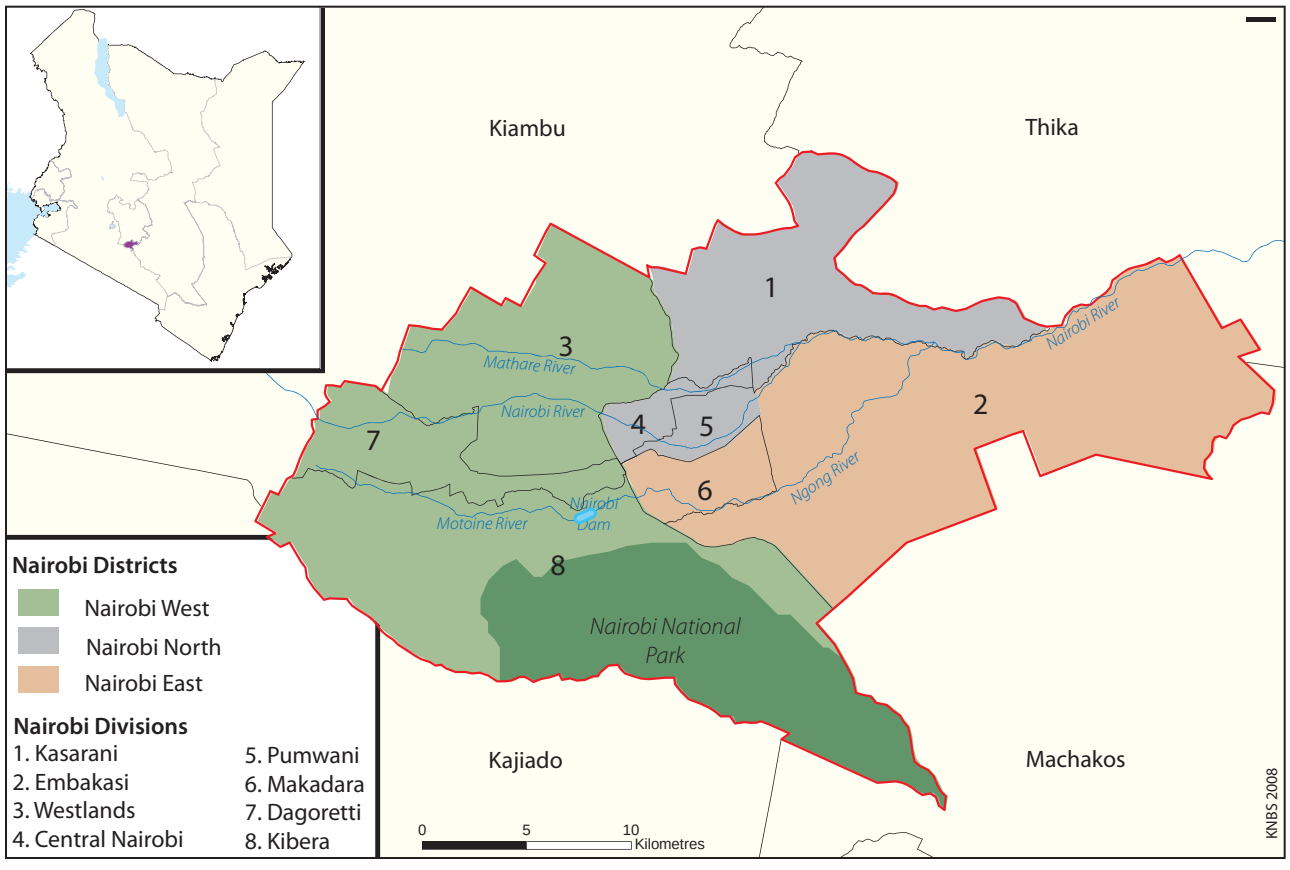
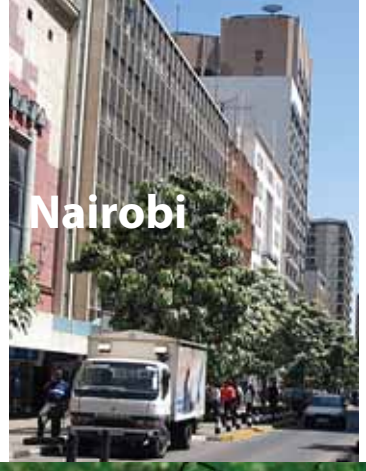


Figure 1: Nairobi's three districts and eight divisions

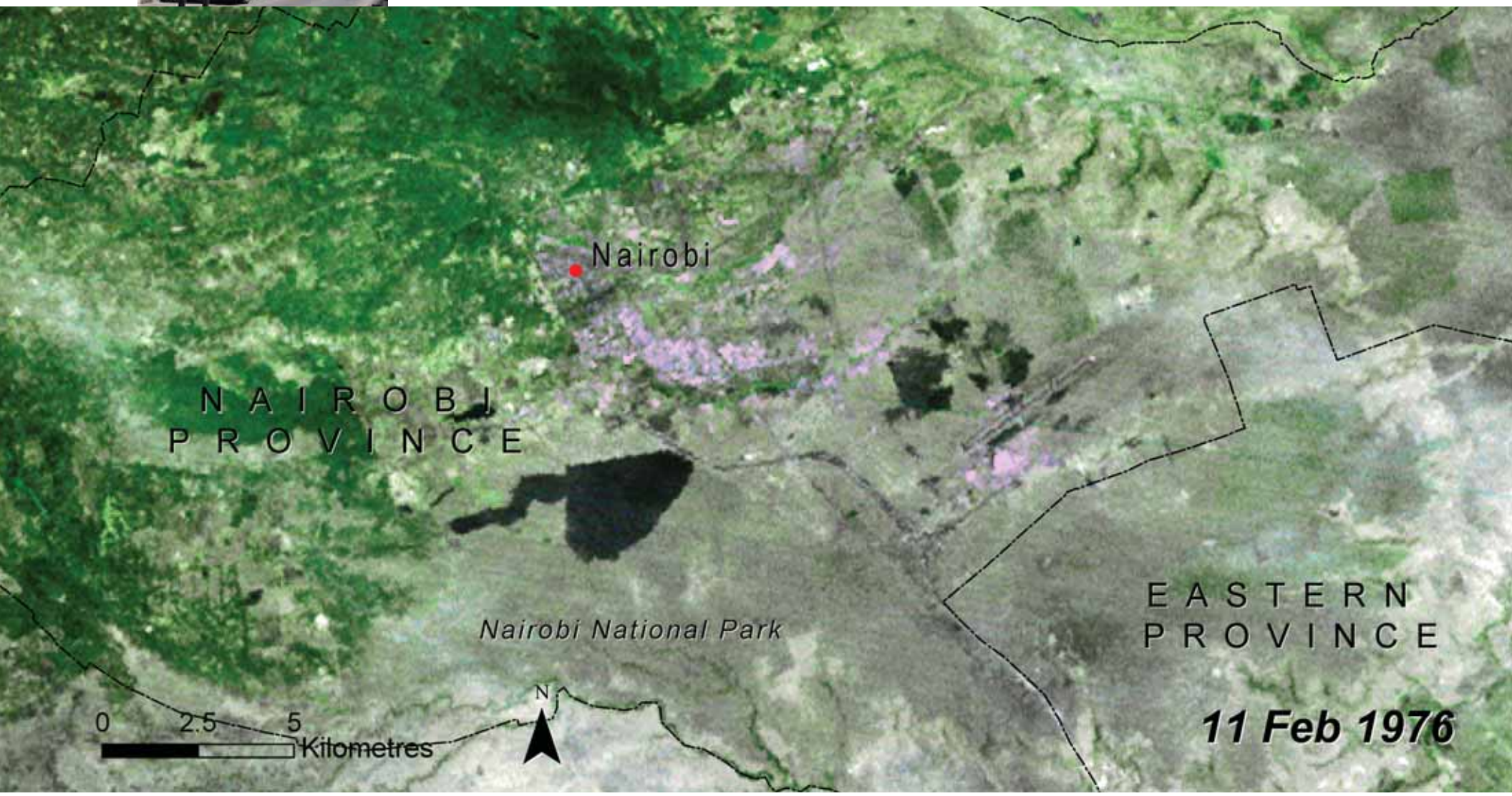
Kenyatta International Conference Centre

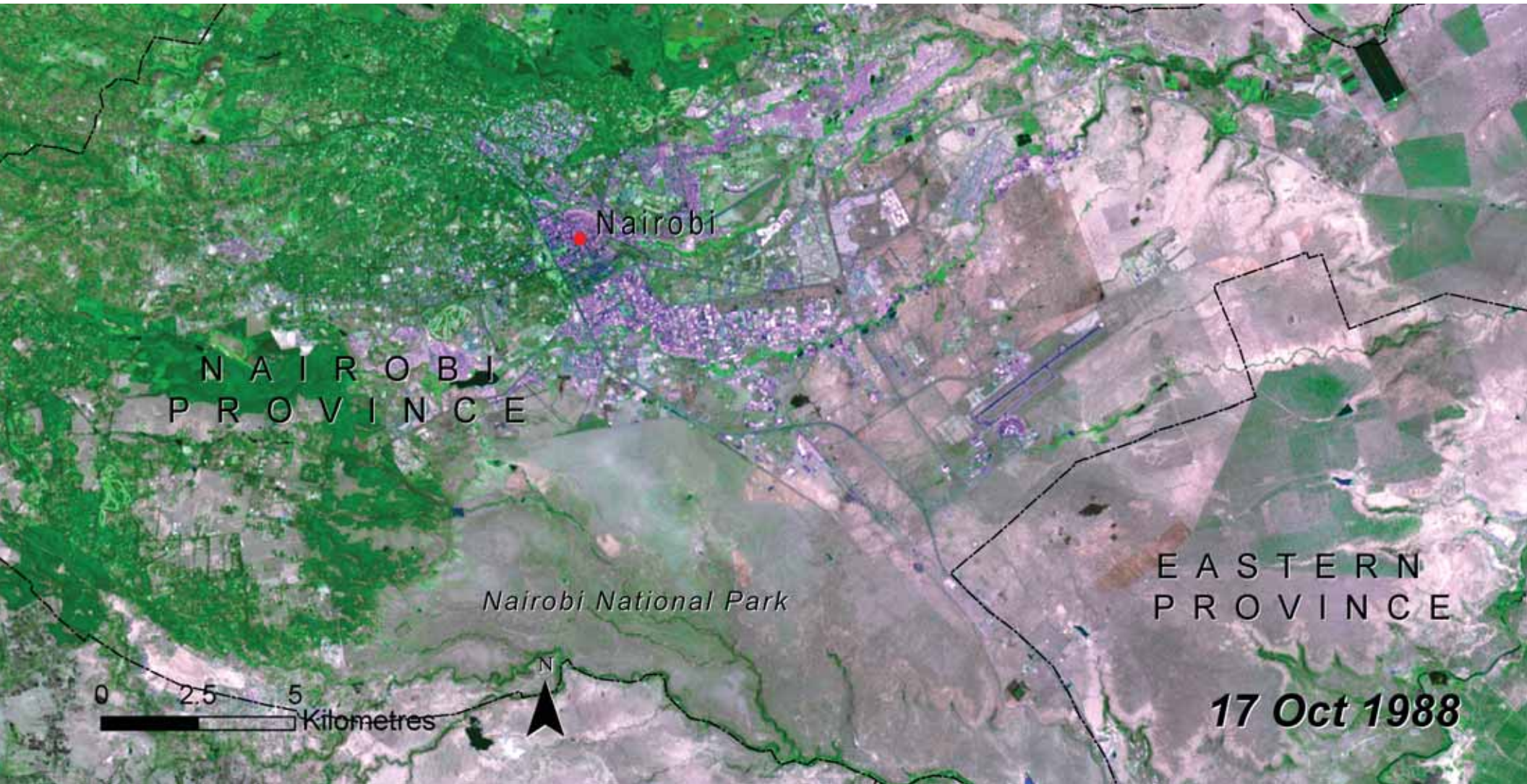
The Kenyatta International Conference Centre, located in the heart of Nairobi's Central Business District, has a 33-story tower and a large amphitheater built in the shape of a traditional African hut.



Nairobi

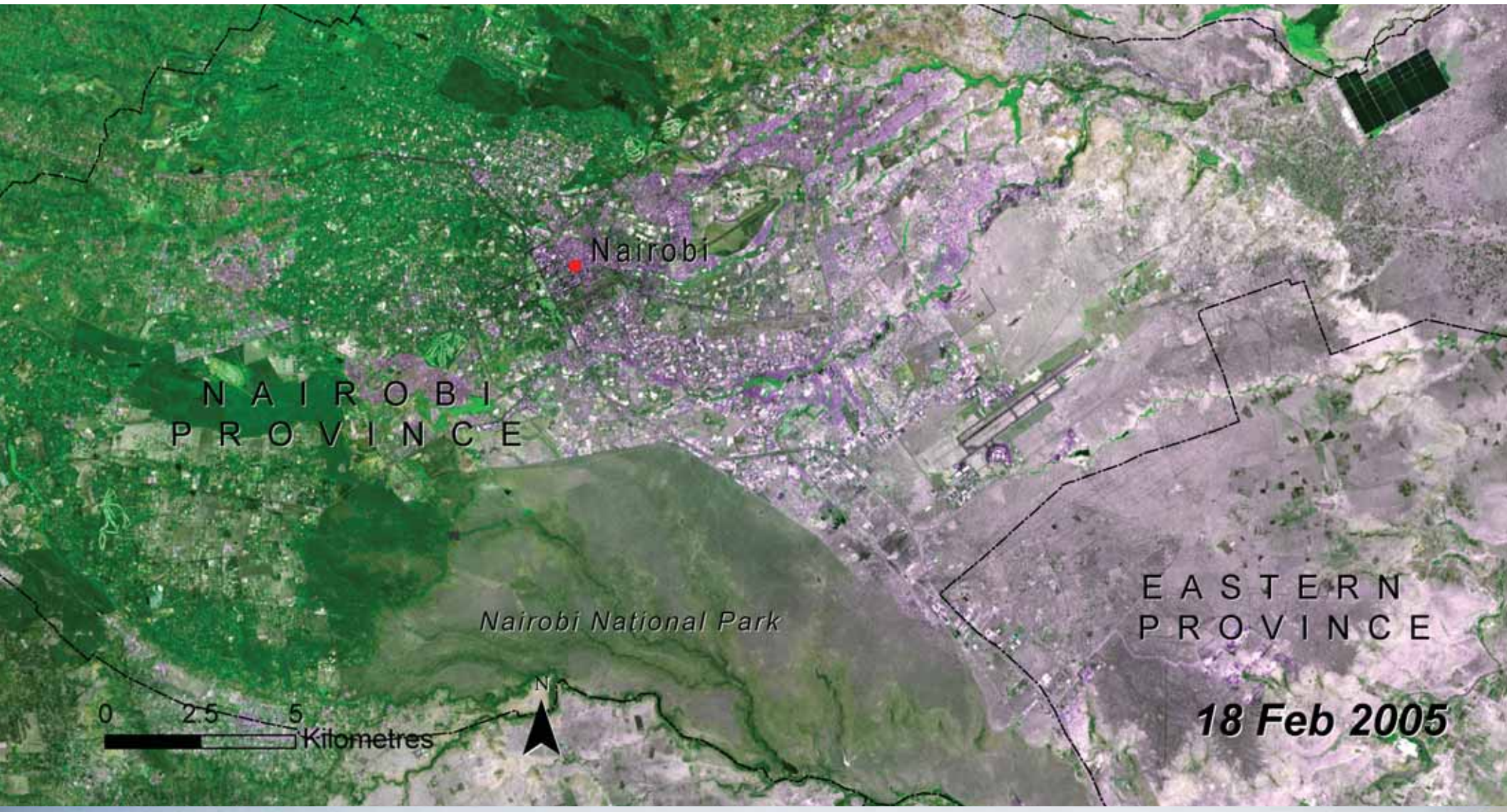
Following its founding in 1902, Nairobi took roughly 40 years to exceed a population of 100 000 people. By independence, 20 years later it had reached around 350 000 people (Olima 2001). Rapidly increasing population has been ongoing since, surpassing one million in the 1980s, two million in the 1990s and now approaching three million residents. While the annual rate of growth has at times exceeded ten per cent, it has more recently decreased to below four per cent per year — still very high by global standards. Nairobi is projected to top 3.8 million by 2015. The footprint of the city's growth can be defined in at least two ways — the official boundaries and the actual changes in settlement, which can be seen in





this series of satellite images. The light purple of the intense urban settlement can be seen steadily growing between 1976 and 2005.

Much of Nairobi's urban footprint is unplanned settlement driven by rapid population growth and urban poverty, among other things. Sprawling informal settlements handicap the city's delivery of social services and negatively impact the quality of life. Informal settlements date to the city's earliest days when European settlers appropriated large tracts of land displacing the local African population with no provision for their resettlement. In the early 1990s, it was determined that over half of the city's population was living in unplanned settlements.



Brian Snelson/Flickr.com

Typical street scene in Nairobi

Population growth: a major driver of environmental change

In 1901, there were only 8 000 people living in Nairobi. By 1948, the number had grown to 118 000 and by 1962, the city had a population of 343 500 people. By the 2009 census, the city's population will be about 3.1 million and in 2015 it is projected to be 3.8 million (Rakodi 1997, CBS 2001). Nairobi's early growth was fuelled by rural migrants and an explosion of growth took place between 1979 and 1989 when 772 624 newcomers came to the city (NEMA 2003). The forces motivating rural-urban migration to Nairobi include better economic prospects, opportunities for higher education and higher wage employment, and the attraction of Nairobi as a market for goods and services.

Nairobi is currently home to nearly three million people and represents about a quarter of Kenya's urban population. A growing economy and swelling population numbers from both in-migration and natural growth are continually increasing the city's size. A significant number of commuters from satellite towns such as Thika, Naivasha, Ngong, and Machakos come into Nairobi daily to work or bring goods and supplies. Daily commuters from such satellite towns contribute an estimated additional half-million people to the city's population.

Nairobi's large and growing population is one of the main forces driving the city's overwhelming environmental challenges. Ongoing rural to urban migration, high natural birth rates, and poor or inappropriate city planning conspire to continue degrading the city's water and air quality. In turn, environmental degradation has impacts on human health and the economy. For the country to achieve the MDGs, progress must be made in Nairobi, as Kenya's capital city and its largest urban centre. An important target is stabilizing the fertility rate at 2.1 by 2010, as recommended by the Population Policy for Sustainable Development (CBS 2004).

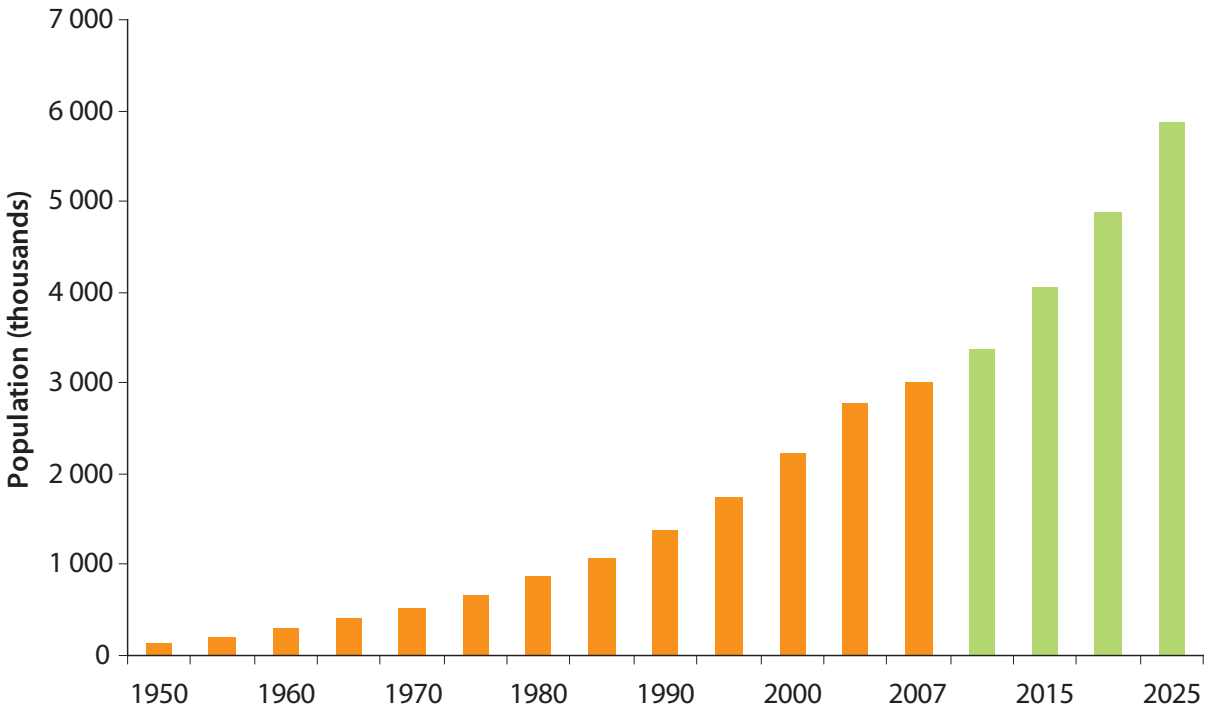


Figure 2: Nairobi's historical and projected population , 1950-2025 (Source: KNBS 2008)

Giraffe strolls in Nairobi National Park with the skyline of the capitol city in the background

Major Environmental Issues

As Nairobi's settlements sprawl outwards, they take over forested and agricultural land, fragmenting and degrading remaining natural areas. In addition, rapid population growth has outstripped the city's ability to deliver adequate services such as education, health care, safe water, sanitation, and waste removal. It has also led to an explosion in the number of cars and other vehicles, leading to ubiquitous traffic jams and high levels of air pollution. As it continues to grow, Nairobi faces the challenge of planning for sustainable urban development that provides adequate housing and services at the same time as it protects air and water quality and the natural environment within and around the city.

The major environmental issues faced by the city and its residents and looked at in this section of the Atlas include rapid urbanization, informal settlements, air and water pollution, water supply and sanitation, and solid-waste management.

Rapid urbanization

Nairobi once had a reputation as a healthy place to live and was called the "Green City in the Sun". Its landscape was characterized by natural forests, labyrinthine riverine ecosystems, and wetlands. The area boasted abundant wildlife in forest groves, marshy wetlands, the Kitengela Corridor, and the Athi-Kapiti plains.

Nairobi's physical expansion has come at the expense of the natural environment. Urban sprawl and the construction of roads and other city infrastructure has led to the loss of forests and other natural areas, such as mixed rangeland and bushlands. As a result, the forest cover receded and was replaced by coffee plantations. Later, the demand for food for the growing population led to the transformation of the city's outskirts to other agricultural uses, which in turn were threatened by further urban growth.

Park entrance sign to Nairobi National Park

Protected green spaces

Nairobi has managed to retain a number of green spaces within and close to the city, which provide its residents with shady recreation areas and visitors with a glimpse of Kenya's renowned wildlife and characteristic vegetation. They also help to maintain biodiversity, filter pollutants from the air, and act as minor water catchments within and on the outskirts of the city.

Although these green spaces have been protected, much of the natural vegetation surrounding Nairobi was lost as the city's boundaries were extended numerous times to accommodate the growing population

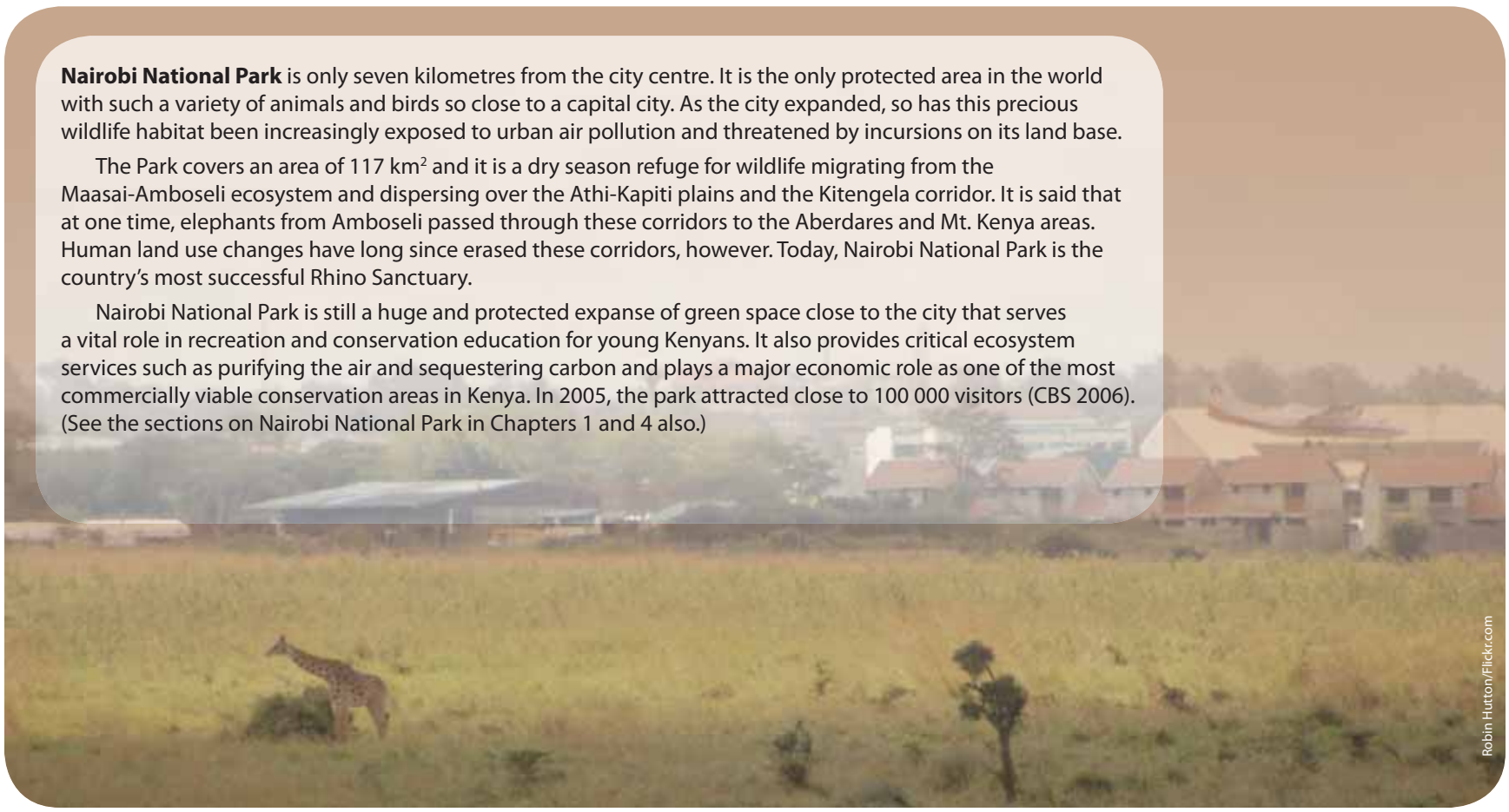
Table 1: Characteristics and biodiversity of key protected areas in Nairobi (Source: KWS 2006, JICA 2005)

Name	Managing Authority	Area (ha)	Common Species	
			Plants	Animals
Nairobi National Park; Established 1946	Kenya Wildlife Service (KWS)	11.0 640.0	Olea africana, Croton dichogamus calodendrum, Themeda, Cyprus, Digitaria, Cynodon, Acacia xanthophloea, Euphobia candelabrum, Apodytes dimidiata, Canthium schimperanum, Elaeodendron buchananii, newtonia sp, Ficus eriocarpa, Aspilia mossambicensis, Thus natalensis, Euphobia brevitorta, Drimia calcarata, Murdannia clarkeana and Crassula sp.	Giraffes, lions, gazelles, buffaloes, hartebeest, wild pigs, wildebeest, warthogs, crocodiles, hippos, and about 400 species of birds
Karura Forest; (Gazetted 1932)	Forest Department	1 063.0	Olea europeae var. africana, Croton megalocarpus, Warburgia ugandansis, Brachyleana huillensis and Uvaridendron anisatum	Monkeys, bush baby, bush bucks, bush pigs, porcupines, duikers, genets, dikdik, epauletted bat, Africa civet
Ng'ong Forest	Forest Department and KWS	638.4	Eucalyptus, Pine, Cyprus, Croton and Cordia species	Over 120 species of birds, over 35 mammals such as leopards, monkeys, reptiles, insects, and amphibians
Ololua Forest	Nairobi City Council and The National Museums of Kenya	667.0	Olea africana, Eleodendron buchananii, Akokanthera schimperi, Brancylaena species, Croton megalocarpus, Carisa edual and Rhus natalensis. Others include aloe, Acaca species	Olive baboons, monkeys, yellow baboons, porcupines, bush baby, bush bucks, bush pig, dikdik, epauletted bat, duikers, African civet, and genets, grey wagtail, Eurasian cuckoo, willow warbler
The Nairobi Arboretum	Forest Department; Established 1907	25.0	Several collections of plant species	Chameleon, skunks, butterflies, dragonflies, ants, bees and beetles, Ayres's hawk eagle
Nairobi City Park	Nairobi City Council	60.0	Olea europeae var. africana, Croton megalocarpus and Warburgla ugandansis	Hundreds of bird species, butterflies and baboons

View of the downtown Nairobi

and the associated need for more land. As the city expanded after its founding, much of the new settlement was unplanned. By 1993, informal settlements housed about 55 per cent of the city's population (Matrix Development Consultants 1993).

Although it covers only 0.1 per cent of Kenya's total surface area, Nairobi has about eight per cent of the country's total population. The city's overall population density is 3 079 people per square kilometre, but this varies significantly from extremely high in the Central and Kibera divisions to very low in the upmarket residential area of Muthaiga in Westlands division. The poorest 60 per cent of Nairobi residents live on only 8.7 per cent of the city's land base, mostly in informal settlements (ITC 2004).



Nairobi National Park is only seven kilometres from the city centre. It is the only protected area in the world with such a variety of animals and birds so close to a capital city. As the city expanded, so has this precious wildlife habitat been increasingly exposed to urban air pollution and threatened by incursions on its land base.

The Park covers an area of 117 km^2 and it is a dry season refuge for wildlife migrating from the Maasai-Amboseli ecosystem and dispersing over the Athi-Kapiti plains and the Kitengela corridor. It is said that at one time, elephants from Amboseli passed through these corridors to the Aberdares and Mt. Kenya areas. Human land use changes have long since erased these corridors, however. Today, Nairobi National Park is the country's most successful Rhino Sanctuary.

Nairobi National Park is still a huge and protected expanse of green space close to the city that serves a vital role in recreation and conservation education for young Kenyans. It also provides critical ecosystem services such as purifying the air and sequestering carbon and plays a major economic role as one of the most commercially viable conservation areas in Kenya. In 2005, the park attracted close to 100 000 visitors (CBS 2006). (See the sections on Nairobi National Park in Chapters 1 and 4 also.)

Scene from a slum area in Nairobi

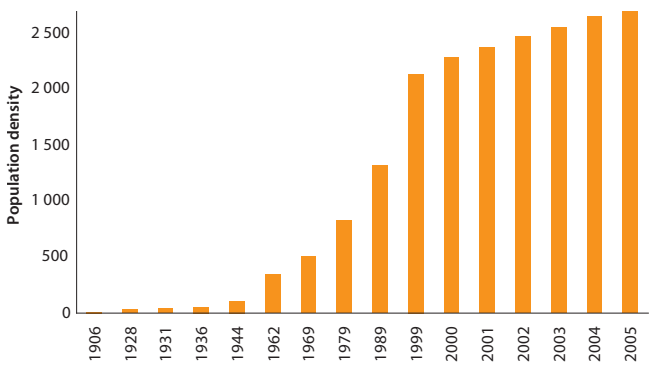


Figure 3: Nairobi's population density, 1906-2005 (Source: CBS 2001)

Informal settlements

Nairobi's rapid growth increased the demand for land and led to land speculation, forcing the poor to settle in fragile and unsavoury areas where they face hardships due to a lack of proper housing and public services and where they are vulnerable to environmental change. Urban poverty, lack of employment opportunities, and inadequate urban planning also conspired in the gradual growth of informal settlements in Nairobi since the city's founding. By 1995, there were a total of 134 informal settlements with 77 589 structures. These settlements had a combined population of 1 886 166 (CCN 2007).

People living in Nairobi's informal settlements, particularly the slums, usually find themselves in the city's most fragile areas, such as flood plains, steep slopes, river valleys, or adjacent to sewers or dump

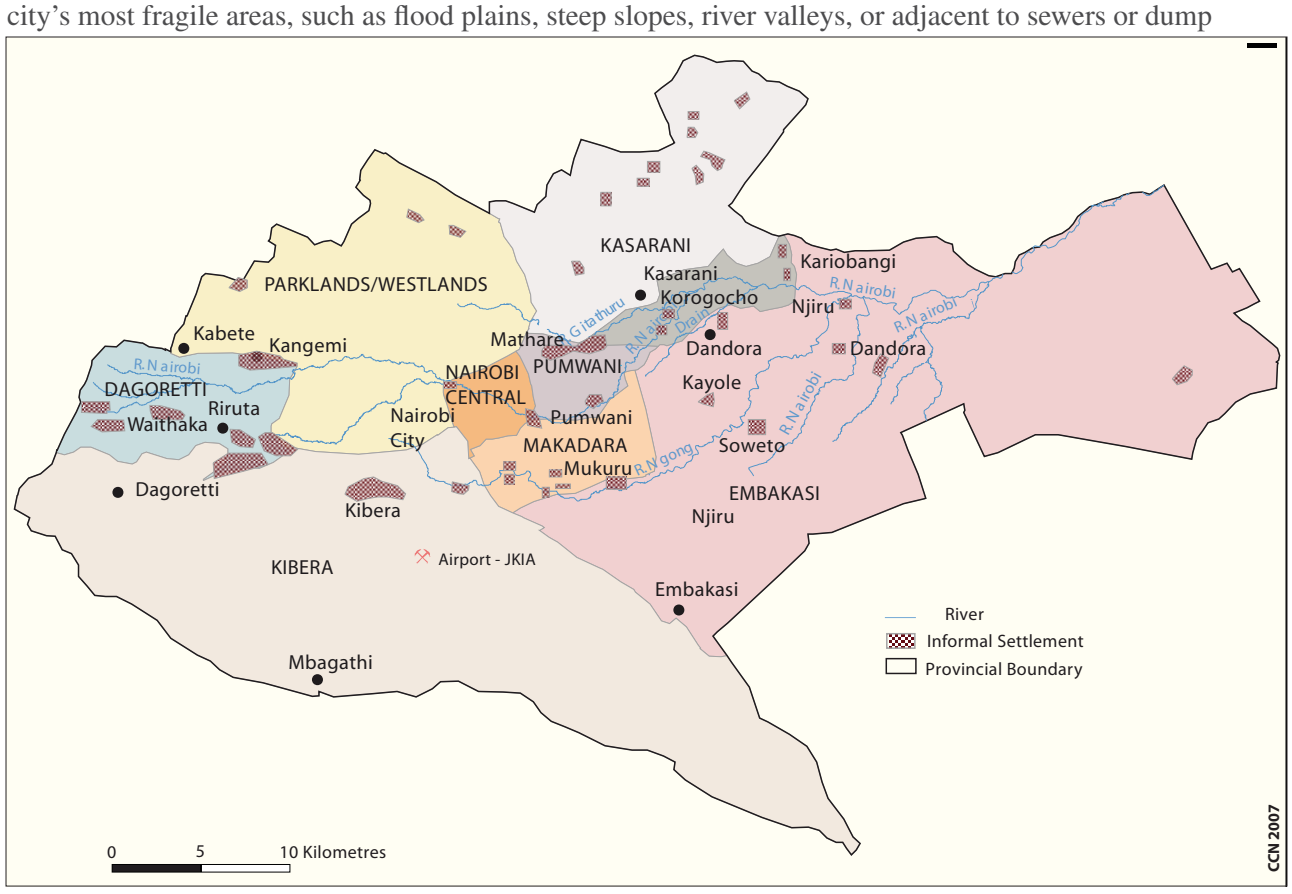


Figure 4: Location of slums in Nairobi

The Dandora Dumping site

sites. The Dandora Municipal Dumping site, which receives most of the city's solid waste, is only about eight kilometres from Nairobi's centre and is surrounded by a low-income residential area. This situation exposes slum residents to floods, land-slides, and health risks from contaminants. In addition, they live in overcrowded conditions with poor sanitation, inadequate and unsafe water, make-shift shelters, and unstable social networks. They also face a high degree of tenure insecurity since most of these settlements are illegal, exposing them to the constant threat of harassment and eviction.

In an attempt to reduce some of the problems of informal settlements, slum upgrading and site and service schemes have been encouraged. The Government of Kenya has established the Slum Upgrading and Low Cost Housing and Infrastructure Trust Fund to serve as a depository for funds mobilized for the Slum Upgrading Programme.

Heavy traffic contributes to air pollution

Air pollution

The main sources of atmospheric pollution are vehicles, industries, emissions from the use of charcoal and firewood, and other municipal sources such as the open burning of waste. The increasing number of cars in the city intensifies traffic and pollution problems. Vehicles emit significant levels of air pollutants, including greenhouse gases and the precursors of smog. Charcoal burning, a very prevalent energy source in the city, emits methane (CH_4) and carbon monoxide (CO) and sends tiny particulates into the air.

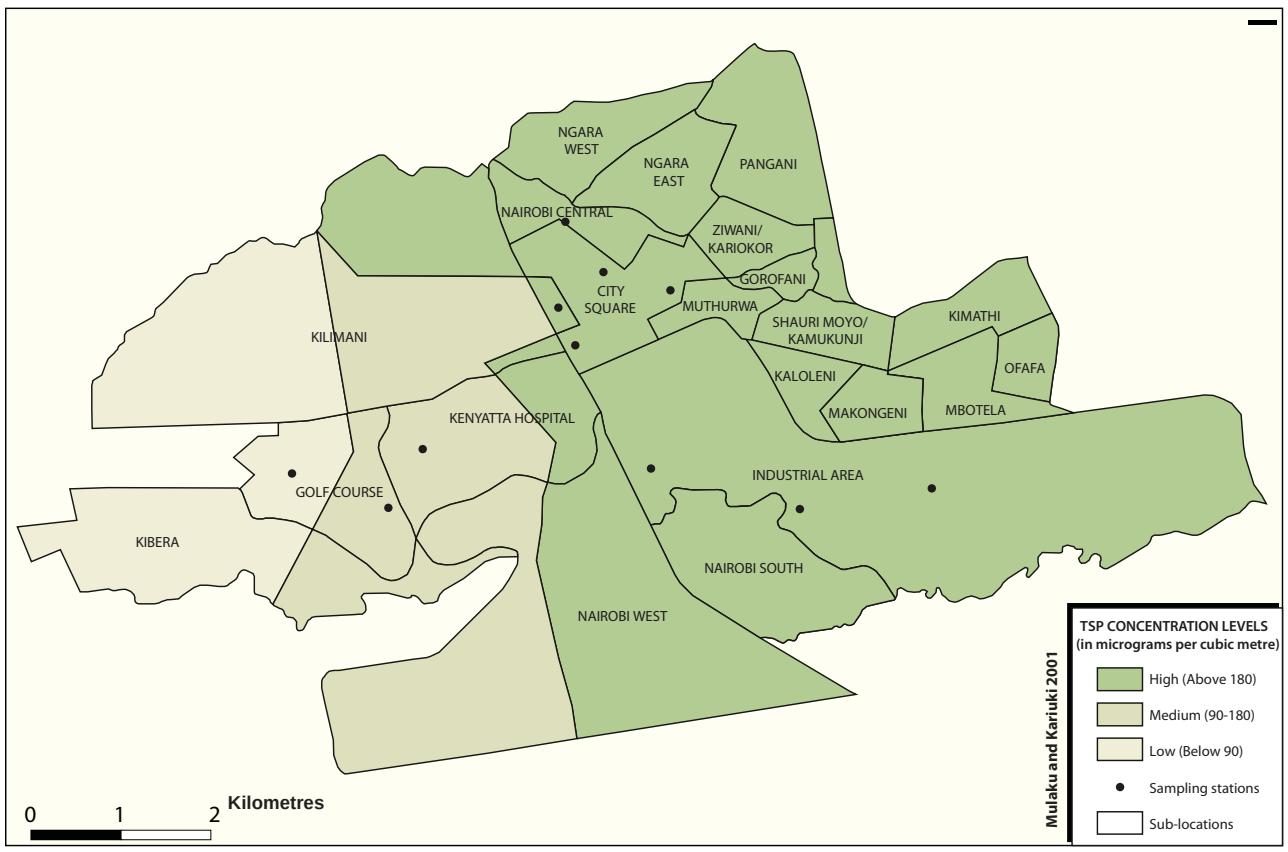


Figure 5: Average total suspended particulates (TPS) over a section of Nairobi

Air pollution adversely affects human health and the environment. Particulates (Figure 5) are associated with respiratory and eye diseases such as asthma, lung cancer, and conjunctivitis, especially in the young and elderly who are more vulnerable. Air pollution is also a major contributor to effects such as acid rain, which has been responsible for much damage to soil, fish resources, and vegetation, often very far from the emission sources.

Water pollution

Ndakaini, Ruiru, and Susumua dams are the principal sources of water for Nairobi. These dams are all on rivers emanating from the Aberdare Forest (one of Kenya's five "water towers"). Several factors compromise the city's water quality, ranging from natural phenomena such as the high fluoride content in groundwater, to anthropogenic factors such as poor wastewater treatment and environmental degradation both within the city and in the surrounding countryside.

The city's wastewater management has not kept up with increasing demands from the growing population and is inadequate to treat the amount of industrial and municipal effluent entering the Nairobi River and other surface waters. Nairobi has changed from a "place of cool waters" to one in which the water is no longer potable or fit for many other useful purposes. A number of factories in Nairobi's industrial area discharge waste directly into the Ngong River, making it the most polluted river in Kenya. Industrial waste effluents include petro-chemicals and metals from micro-enterprises and "Jua-kali". As well, oil and grease from the busy roads run off into adjacent waters.

The Nairobi River also receives improperly treated effluents from the Dandora Sewage Treatment Plant and several drainage channels that gather storm water from Nairobi City. Domestic garbage from informal settlements that have no public waste collection services also finds itself into the river as does sewage from pit latrines and other on-site sewerage-disposal methods. Sanitation facilities are very basic in many informal settlements, consisting of earth drains, communal water points, pit latrines shared by many people, and no systematic solid-waste disposal.

In addition to locally generated water pollution, the city receives effluents that enter the rivers from human activities further afield. The Nairobi River Basin consists of three major rivers (Nairobi, Ngong, and Mathare) whose catchments are found within the Kikuyu and Limuru Hills. Figures 7 and 8 highlight major points of organic, solid waste, and heavy metal pollutants within the basin.

Improperly treated sewerage and uncollected garbage have contributed to a vicious cycle of water pollution, water-borne diseases, poverty, and environmental degradation. Water pollution carries environmental and health risks to communities within Nairobi, especially the poor who may use untreated

Trash and garbage wash down the Nairobi River polluting the water here and downstream

Figure 6: Wet season pollution hotspots

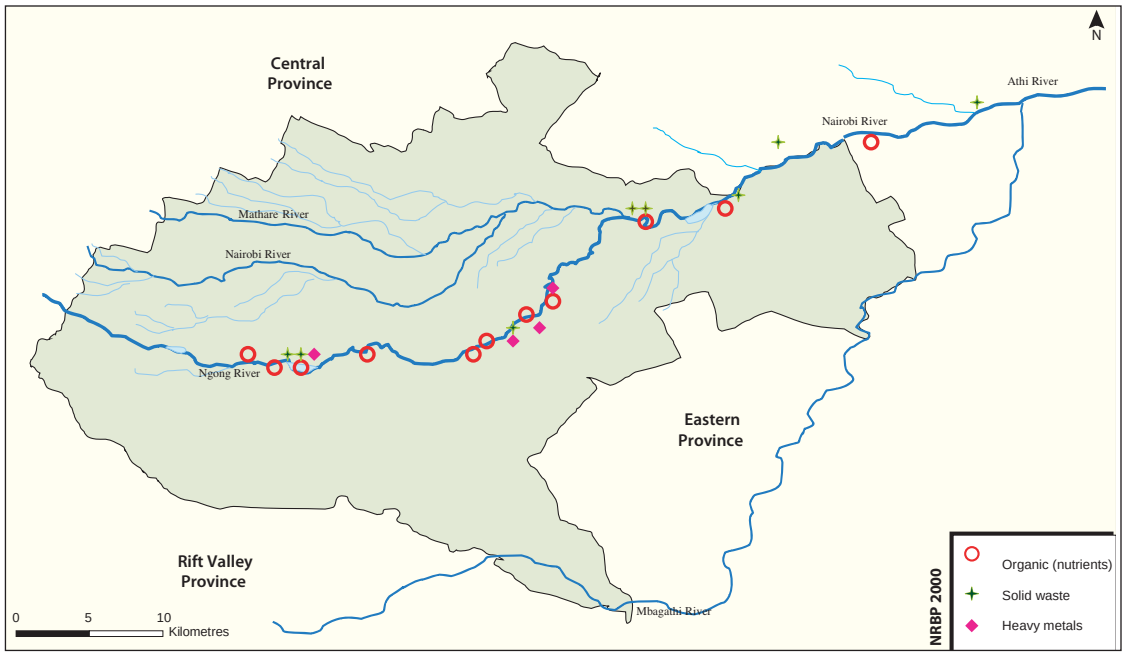
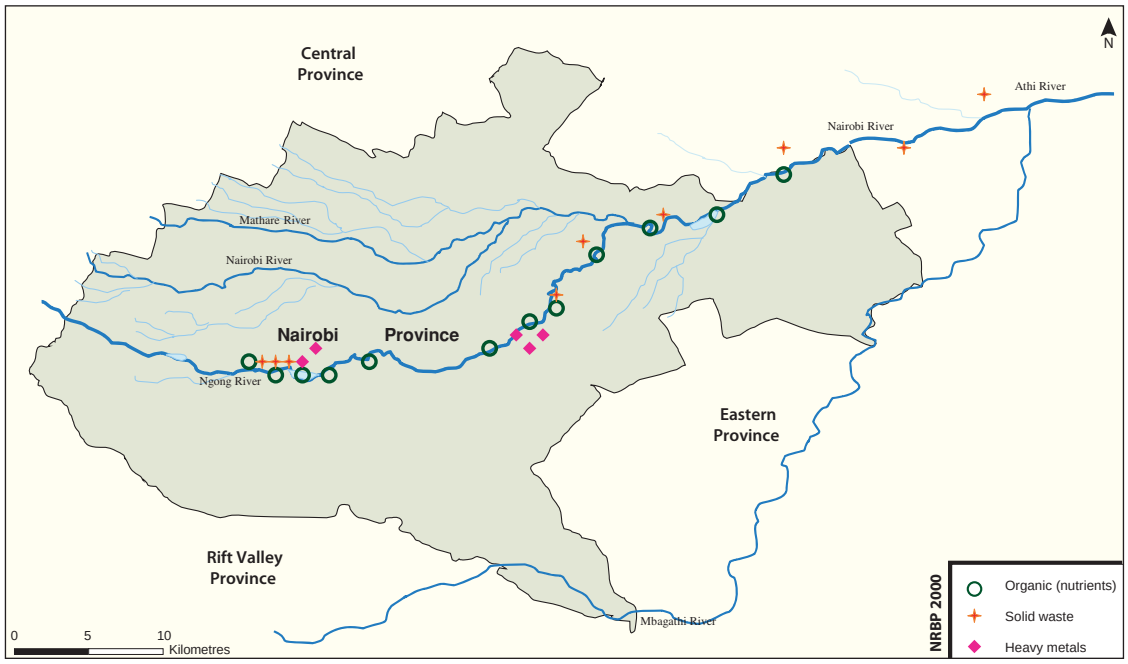


Figure 7: Dry season pollution hotspots



water in their homes and to irrigate their gardens. Farmers along the Nairobi River and its tributaries commonly use polluted waters and raw sewage for irrigation, exposing both farm workers and customers who consume the food crops to potential health problems such as diarrhoeal disease and helminthic infections. Almost half of the vegetables consumed in the city of Nairobi are grown on the banks of polluted rivers. All these impacts affect human health and productivity and challenge Kenya's ability to reach targets under the Millennium Development Goals (as discussed in Chapter 2).

To reduce the sources of water pollution in the Nairobi River and address some of the impacts on both people and the riverine ecosystem, the Nairobi River Basin Programme (NRBP) was initiated in 1999. It is a multi-stakeholder effort with the vision of a restored riverine ecosystem with clean water for the capital city and a healthier environment for the people of Nairobi. Its goal is to rehabilitate, restore, and manage the Nairobi River ecosystem to improve livelihoods, especially for the poor, enhance biodiversity, and provide a sustainable water supply for domestic, industrial, recreational, and emergency uses. NRBP identified five key goals to improve the water quality and environment in the Nairobi River Basin:

- Develop environmental management and planning systems;
- Rehabilitate and restore the Nairobi Dam;
- Develop and implement water quantity and quality measuring protocols;
- Enhance service delivery, environmental conservation, and sustainable use of resources; and
- Sustain public awareness of, and participation in, environmental issues directly affecting the Nairobi River Basin (UNEP 2008).

The City Council of Nairobi improving access to better sanitation facilities by constructing more facilities within common areas

Sanitation

Nairobi faces an enormous challenge in providing adequate public sanitation facilities, sewage disposal, and refuse collection, a problem that is compounded as the population increases. Improperly treated sewerage and uncollected garbage have contributed to a vicious cycle of water pollution, water-borne diseases, poverty, and environmental degradation.

Solid waste management

Waste management is a growing problem in Nairobi. Increasing urbanization, rural-urban migration, rising standards of living, and rapid development associated with population growth have resulted in increased solid waste generation by industrial, domestic, and other activities. This increase has not been accompanied by an equivalent growth in the capacity to address the problem. In 1992, from 800 to 1 000 tonnes of solid waste was generated in Nairobi every day, of which less than ten per cent was collected; by 2002, the amount had grown to 1 530 tonnes per day of which 40 per cent was either uncollected, or disposed of by burning or illegal dumping (Syagga 1992, CCN 2007). The proper management of waste has thus become one of the most pressing and challenging environmental problems in the city.

Waste in Nairobi comes from a variety of household, service, and industrial processes in the following proportions: domestic sources: 68 per cent; industrial: 14 per cent; roads: 8 per cent; hospitals: 2 per cent; markets: 1 per cent; and 7 per cent from other sources (NEMA 2003). Food waste, plastic, and paper are the most dominant forms of solid waste in Nairobi (Figure 9). One of the most ubiquitous forms of visible waste is the plastic bag. By 2007, over two million plastic bags were being handed out every year in Nairobi alone. Once released in the environment, they choke wildlife, pollute the soil, and serve as breeding grounds for mosquitoes. In the footsteps of several other African countries, as of 1 January 2008, Kenya imposed a national ban on the importation and distribution of plastic bags less than 30 microns in thickness (NEMA 2008).

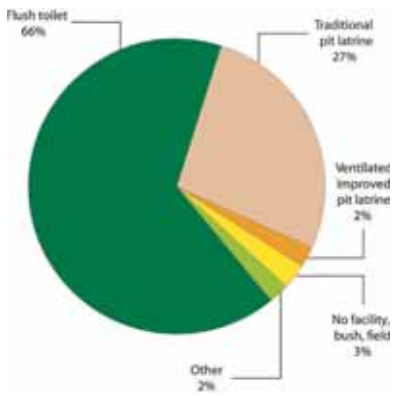


Figure 8: Sanitation facilities used by Nairobi residents (Source: CCN 2007)

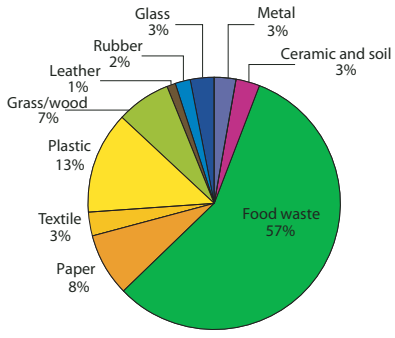


Figure 9: Characteristics of solid waste generated in Nairobi (Source: CCN 2007)

Planning for the Future

In 2007, a state of the environment report for the city was prepared (*City of Nairobi Environment Outlook*) that provided a baseline to assess progress in addressing the city's environmental problems and provided stimulus to the local government to mainstream environmental issues in all development and city planning activities.

In 2008, the Government of Kenya produced the Nairobi Metropolitan Development Plan. Under this development plan, the boundaries of the city (Nairobi Metropolitan Area) will be expanded to include adjoining towns and municipalities (Figure 10).

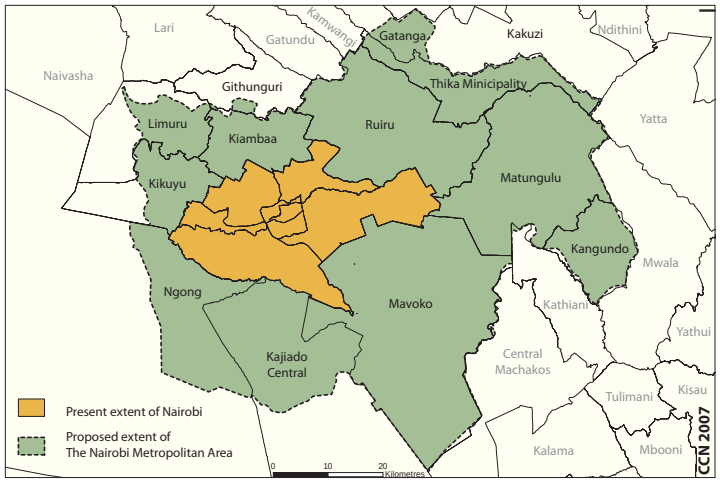


Figure 10: Present and proposed extent of the Nairobi Metropolitan Area

The plan's other goals include the following:

- Develop integrated road, bus, and rail infrastructure for the Metropolitan Area to provide an efficient mass transport system;
- Replace informal settlements with affordable low cost housing;
- Develop and enforce planning and zoning regulations;
- Prepare a spatial plan for the Metropolitan Area;
- Develop efficient water supply and waste management infrastructure;
- Promote, develop, and invest in sufficient public utilities, public services, and world-class infrastructure for transforming Nairobi into a global competitive city for investment and tourism;
- Identify and implement strategic projects and programmes requiring support by the Government;
- Promote the Nairobi Metropolitan Area as a regional and global services centre for financial, information and communication technology, health, education, business, tourism and other services; and
- Develop a sustainable funding framework for the development of identified urban and metropolitan areas.

Given that environmental degradation in Nairobi has such an important impact on such a large number of people as well as on the country's economy and its international reputation, Kenya needs to move quickly and decisively on this plan.

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Acronyms

ALRMP	Arid Lands Resource Management Project
ARTS	ASRC Research & Technology Solutions
ASAL	Arid and Semi-Arid Land
AWF	African Wildlife Foundation
CBS	Central Bureau of Statistics
CCD	Convention to Combat Desertification
CCN	City Council of Nairobi
CH_4	methane
CI	Conservation International
CITES	Convention on International Trade in Endangered Species
CO	Carbon Monoxide
CO_2	Carbon Dioxide
DEWA	Division of Early Warning and Assessment
DEPHA	Data Exchange Platform For The Horn of Africa
DRSRS	Department of Resource Surveys and Remote Sensing
EIA	Energy Information Administration, United States Department of Energy
ENSO	El Niño/Southern Oscillation
FAO	Food and Agriculture Organization
FAS	Foreign Agricultural Service
FEWS NET	Famine Early Warning System Network
FR	Forest Reserve
GDP	Gross Domestic Product
GoK	The Government of Kenya
GRID	Global Resource Information Database
ha	hectares
IBA	Important Bird Areas
ILO	International Labour Organization
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
ISSD	International Institute for Sustainable Development
ITC	International Institute for Geo-Information Science and Earth Observation
IUCN	International Union for Conservation of Nature and Natural Resources
JICA	Japan International Cooperation Agency
KENGEN	Kenya Electricity Generating Company
KFS	Kenya Forest Services
KFWG	Kenya Forests Working Group
kg	kilograms
KIFCON	Kenya Indigenous Forests Conservation Programme
KLA	Kenya Land Alliance
km	kilometres
km^2	square kilometres
km^3	cubic kilometres
KMD	Kenya Meteorological Department
KNBS	Kenya National Bureau of Statistics
Ksh.	Kenyan Shilling
kWh	kilowatts per hour
KWS	Kenya Wildlife Service
m	metres
m^2	square metre
m^3	cubic metre
MDGs	Millennium Development Goals
MENR	Ministry of Environment and Natural Resources
mm	millimetres
MW	Megawatts
NEE	National Economies Encyclopedia
NASA	National Aeronautics and Space Administration
NEMA	National Environment Management Authority
NPP	Net Primary Productivity
NRBP	Nairobi River Basin Programme
ODA	Official development assistance
OECD	Organisation for Economic Cooperation and Development
PPP	Public-private partnerships
RCMRD	Regional Centre for Mapping of Resources for Development
SGT	Stinger Ghaffarian Technologies
SoK	Survey of Kenya
t	tonnes
UMD	University of Maryland
UN	United Nations
UNDG	United Nations Development Group
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNFPA	United Nations Population Fund
UNICEF	United Nations Children's Fund
UNPD	United Nations Population Division
UNStats	United Nations Statistics Division
UNU	United Nations University
URT	United Republic of Tanzania
USAID	United States Agency for International Development
USDA	United States Department of Agriculture
USGS	United States Geological Survey
VIP	Ventilated Improved Pit
WCMC	World Conservation Monitoring Centre
WGCCD	Working Group on Climate Change and Development
WCPA	World Commission for Protected Areas
WHO	World Health Organization
WRI	World Resources Institute
WWF	World Wildlife Fund
yr	year

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